Characteristics of the High Altitude Terrestrial Polar Wind during the Approach to Solar Maximum

With the plasma source operating on Polar, the TIDE is well suited for observing characteristics of the terrestrial polar wind outflow. The plasma source has been operated semi-routinely during 1997, 1998, 1999, and 2000. A large number of orbits, distributed over the approach to solar maximum, have thereby been provided for which the spacecraft potential is reduced to less than a few volts, even at high altitudes in the polar cap. We have performed a numerical analysis of the TIDE Stops only data product for all of north polar cap passes for which the plasma source was operating. A difficulty exists in that the Stops only data are summed over a 180° fan transverse to the Polar spacecraft spin plane and the effective geometric factor, which depends on the width of the angular distribution is not know a priori. The angular dimension of the spin distribution gives an estimate of the width of the distribution across TIDE channels, and therefore provides a required geometric factor correction applied to the Stops only counts. A database has been created that contains simple moments of the energy and spin angle distributions on a spin-by-spin basis. Quantities derived include flux, mean energy, the width of the energy distribution, mean flow direction with respect to the geomagnetic field, and the width of the angle distribution. Other quantities stored in this database include solar wind parameters (IMF components, solar wind density and speed), Dst, and Kp.

Figure 1a shows a fairly typical pass early in the mission. Spin-time (top panel) and energy time (bottom panel) spectrograms of TIDE stops only data are shown. The plotted units are energy flux as scaled by the color bar shown. Typical energy flux values are seen to be in the neighborhood of 1-3 x 10^7 eV/cm^2-st-eV-s. Figure 1-b (right panel) shows a histogram of the flow energies observed during this pass. Though the energy is clearly variable (Figure 1a, bottom panel), it is fairly strongly peaked at just above 10 eV. Given a typical flow energy of 10 eV, this yields a typical particle flux for this pass of 1-3 x 10^6 particles/cm^2-st-eV-s, corresponding to a particle flux mapped to 1000 km altitude of 4 – 12 x 10^8 particles/cm^2-st-eV-s. Though this pass is typical, there is significant variability from pass to pass in the typical flux, flow energy, temperature, and density. Su et al. [1998] provided a description of terrestrial polar wind properties at both low (5000 km) and High (~ 8 R_E) altitudes, based on limited data acquired during the spring of 1996. We propose to provide a statistical summary of the properties of the terrestrial polar wind flow spanning four years on the approach to solar maximum, by extracting physical properties from the database we have collected. We will also study the short time variability of this flow to try to determine the processes that drive it.

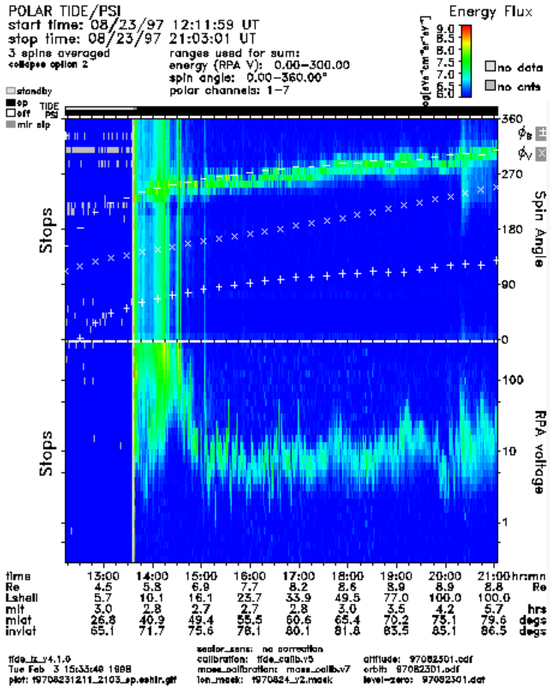
An interesting aspect of the high altitude terrestrial polar wind outflow involves its composition and the dependence of its composition upon solar wind drivers [Moore et al., 1999] and geomagnetic activity. Judging from the energy distributions, the polar wind observed by TIDE is typically composed of a single species, presumably H^+ [Su et al., 1998], though multi species flow is not uncommon.. The bottom panels of Figure 2 show TIDE measurements from three consecutive Polar passes with PSI operating, on June 8-9, 1997. In the top panel is shown the value of the Dst index through the month of June. The development of two component flow observed by TIDE during the second two passes seems to be correlated with the advent of enhanced storm activity, as shown in the Dst. However, this correlation is not one to one. Though not common, there are times observed when multi-species outflow is observed, but no remarkable signature is present in the Dst. In our database, we have characterized the flow, not only in the case of a single energy peak, but also in the case of multiple peaks. We are therefore in a position to study the occurrence and energetics of multi-species polar wind outflows. We will further exploit the database we have created to study the composition of the terrestrial polar wind outflow, and its dependence upon solar wind drivers and geomagnetic activity.

We note here the systematic decrease in typical flow energy as each pass progresses in the bottom panels of figure 2. This type of effect is even more apparent later in the mission, when the apogee has precessed to lower latitude and northern polar cap passes include large variations in altitude. This systematic variation in flow energy may be either due to a velocity filter effect [Lockwood et al., 1985] or to an inherent variation in flow energy with altitude. We will investigate this type of observation to determine its origin.

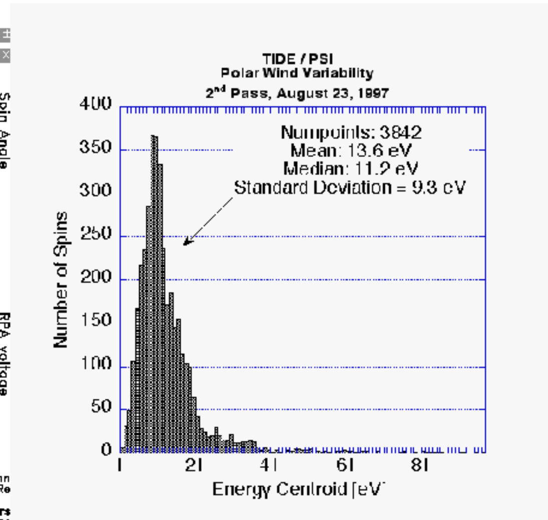
Lockwood, M., T.E. Moore, J.H. Waite, Jr., C.R. Chappell, J.L. Horwitz, and R.A. Heelis, The geomagnetic mass spectrometer – Mass and energy dispersion of ionospheric ion flows into the magnetosphere, *Nature*, 316, 612, 1985.

Moore, T. E., W. K. Peterson, C. T. Russell, M. O. Chandler, M. R. Collier, H. L. Collin, P. D. Craven, R. Fitzenreiter, B. L. Giles, and C. J. Pollock, Ionospheric mass ejection in response to a CME, *Geophys. Res. Lett.*, 26(15), pp. 2339-2342, 1999.

Su, Y.-J., J.L. Horwitz, T.E. Moore, B.L. Giles, M.O. Chandler, P.D. Craven, M. Hirahara, C.J. Pollock, Polar Wind Survey with the Thermal Ion Dyanmica Experiment/Plasma Source Instrument Suite Aboard POLAR, *J. Geophys. Res.*, **103**, 29,305, 1998.



1-a



1-b

Figure 1

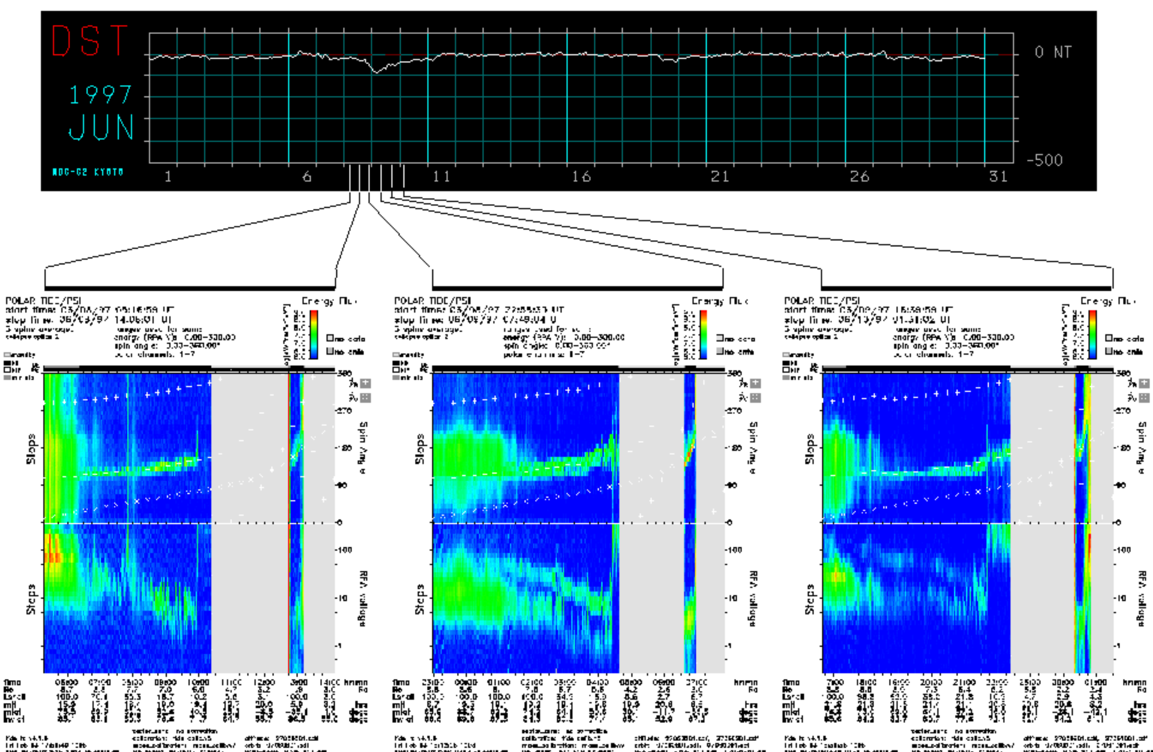


Figure 2